CURRENT LITERATURE

BOOK REVIEWS

Transpiration of plants

BURGERSTEIN'S[1] second volume on the transpiration of plants constitutes a supplement to his well known work published in 1904. It presents a critical summary of the literature on transpiration down to and including the year 1920. The first volume was based on 394 publications, while in the second volume 505 have been added, many of which were published in English, and an unusually large number by women. The first volume contained 30 chapters, the second 32. They parallel each other very closely, but a comparison of the two brings out rather clearly the more recent trend of this line of investigation. Many of the subjects mentioned in the text in the first volume are here given separate chapter treatment. Thus the principal advances made in the study of the transpiration of plants during the last sixteen years are clearly indicated. A number of new terms and phrases appear in the second volume which were not used in the first, and most of which are concerned with an attempt on the part of the investigator to obtain a more satisfactory basis for the comparison of the amount of transpiration of different plants at different times and under different conditions.

Relative transpiration is the ratio of transpiration of any plant at any time to the water loss from a standardized water surface, or from any other water-evaporating surface exposed under the same conditions as is the plant, and for the same length of time. In most of the papers in which this term is used the assumption has been made that evaporation is a correct measure of the environmental conditions affecting transpiration, and that therefore any variation which occurs in the plotted graph showing ratio of transpiration to water loss is due to some adjustment on the part of the plant. This assumption is made without sufficient reason and is not well supported by experimental data.

Index of transpiring power differs from relative transpiration only in that a cobalt paper is introduced as an indicator of relative water loss; consequently any errors inherent to the relative transpiration method are not eliminated by this method, and there is also introduced the uncertainty connected with the use of the cobalt paper. Both of these methods have been used extensively and have stimulated an unusually large amount of investigation. While the accuracy of the results must be questioned, it is undoubtedly true that our knowledge of transpiration has been greatly advanced by their application.

[1] BERGERSTEIN, ALFRED, Die Transpiration der Pflanzen. Zweiter Teil (Ergänzungsband). Jena. 1920.

Specific transpiration is really an expression of the rate of drying of plants. It is the percentage of the total water content of the plant lost during a definite time. The loss would naturally be very high in plants with low water content and very low in plants such as succulents, which have very high water content.

Correlative transpiration has been used in the sense of relative transpiration, and also to express the inter-relationship between transpiration of leaves in the shade and in the sun, bringing out the fact that leaves in the sun will often withdraw the water from the leaves in the shade, and although their transpiration is much more rapid than leaves exposed in the shade, will continue fresh while those in the shade wilt.

Water requirement is used in two different ways. In the broadest application of this word it is synonymous with the expression "water relation of plants," but by many it has been used in a narrow sense to signify the ratio of water consumption to dry matter produced during the growth of a plant.

Many new methods have been employed, both for determining the stomatal openings and measuring the water loss. The epidermis has been fixed either in alcohol or picric acid and the openings measured by microscopic examination. The rate of the flow of air through the leaf, or the porometer method, which has several modifications, has enabled the experimenter to estimate the relative difference in the openings of the stomata. To this method has also been applied automatic recording devices.

One of the simplest and most useful methods for determining whether or not the stomata are open is the infiltration method. Absolute alcohol, petroleum ether, or other fluids, when dropped on a leaf with open stomates penetrate into the mesophyll. This penetration is easily observed, and the technique is so simple that observations can be made rapidly.

Several modifications of the gas diffusion or gas infiltration method have been employed by different workers. A large variety of potometers and atmometers have been devised. Nothing especially new has appeared among the porometers, but a number of new types of atmometers have been employed. These consist chiefly of porcelain filters or of filter paper saturated with water which is allowed to evaporate and the loss determined by weighing.

In the measuring of transpiration loss no entirely new methods have been devised, although great improvements have been made on the older methods. Automatic weighing devices have been greatly improved, and there has been considerable improvement also in the methods of measuring transpiration by collecting the transpired water. There are now several types of automatic instruments, chiefly of the step-by-step type, which give satisfactory records of transpiration loss.

Efforts to find algebraic equations or formulae by which transpiration can be estimated from the observed environmental conditions, has resulted in a clearer understanding of the factors affecting transpiration, but no entirely satisfactory equations have been deduced. In fact, experimental data are hardly sufficient at the present time to enable one to evaluate properly such factors as wind, light, etc., and this, combined with the uncertainty of the

effect of stomatal movement, makes the problem an especially difficult one. It is true, however, that the effect of external conditions on transpiration, determined usually by comparing transpiration at different places at different portions of the day or year, is now much better understood than at the time of publication of the first volume. These results have been obtained usually with the help of either painstaking direct weighings, or by the use of automatic transpiration records, the evaporation, temperature, sunlight, wind, and wet bulb depression having been simultaneously determined.

Water requirement of plants used in its narrow sense is the amount of water consumed by a plant during its period of growth in the production of a unit weight of dry matter. It is evident, therefore, that any factor which affects transpiration and any factor which affects the growth of plants will modify this ratio. Where conditions are most favorable for growth the water requirement is likely to give the lowest value, while if conditions are not favorable for growth, even though the transpiration rate be relatively low, the water requirement will still be high. The practical value of this measurement in connection with the production of cultivated crops has led to a large number of determinations covering many of the more important crop plants. The relative consumption of water during growth and the effect of environmental conditions on the water requirement are less easily determined than the effect of environmental conditions on transpiration, since not only do the conditions control the rate of transpiration, but also affect the relative rate of growth for production of dry matter.

Although very little work has been done on the effect of insufficient soil moisture on the transpiration of plants, a great mass of data has been accumulated on the amount of moisture in the soil at the time plants wilt. Although results are somewhat conflicting, it has been found that there is a relatively definite percentage of soil moisture content, beyond which the movement of moisture in the soil is so slow as to make it practically impossible for a plant to supply its transpiration demand from the mass of soil through which its roots ordinarily extend. This moisture content has been referred to as the wilting coefficient.

Many papers have dealt with structure and morphological investigations for lessening transpiration. Although the value of transpiration in reducing the temperature of leaves has been brought out by a number of investigators, its value in relation to the nutrition of plants has not fully been admitted.

The difficulty of getting together so large a volume of English literature, especially at a period when war made access to literature from English speaking countries difficult or impossible, must have been very great. This work is a valuable summary, and no investigation of transpiration is feasible without first consulting it. It is impossible to bring into the work all of the material contained in the original papers, and these should always be consulted. A careful perusal of this work shows clearly that there is not a single line of investigation at the present time which does not afford a good starting point for further research.—H. L. SHANTZ.